REMARKS

The non-Final Office Action was issued on pending claims 1-19. Claims 2, 3 and 13-18 have been withdrawn from consideration. In this Response, claims 1, 4, 5, and 19 have been amended, and no claims have been added or canceled. Thus, claims 1, 4-12 and 19 are pending and under consideration.

**Oath/Declaration**

The Office Action at page 2 objects to the oath or declaration and states that it does not include the notary's signatures of the first two inventors. Applicants signed and submitted a Declaration instead of an oath and used the Patent Office's English and Japanese bilingual Declaration Form PTO/SB/106. The Declaration does not require a notary signature. See MPEP § 602. Applicants note that the first two inventors signed their names in Japanese and the second two inventors signed their names in Japanese and English.

**Specification**

The Office Action at page 2 objects to the specification as containing an informality. In response, the specification has been amended at page 15, line 10 to replace the word "an" with "a" to correct the informality. Thus, Applicants submit that the objection to the specification has been overcome.

**Claim Objections**

The Office Action at page 2 objects to claims 4, 5, and 19 as containing informalities. In response, claims 4, 5, and 19 have been amended to correct the informalities. Specifically, claims 4, 5, and 19 have been amended so that they only depend from claims which are currently under consideration. Thus, Applicants submit that the objection to the claims has been overcome.

**Claim Rejections – 35 U.S.C. § 112**

On pages 2 and 3 of the Office Action, claims 1, 4-12, and 19 were rejected under 35 U.S.C. § 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which Applicant regards as the invention.

The Office Action suggests inserting "cathode or anode" after "hollow" in claim 1, line 14. Applicants thank the Examiner for the suggested clarifying amendment.

Claim 1 has been amended to recite "a hollow electrode discharge generation area." Accordingly, the hollow electrode discharge generation area can be a cathode, anode, or another type of electrode.

Applicants respectfully submit that the amendment merely clarifies the claim and is not made for substantial reasons related to patentability. Applicants also submit that no subject matter has been surrendered by the claim amendment.

Applicants respectfully submit that the § 112, second paragraph, rejection has been overcome.

**Claim Rejections – 35 U.S.C. § 102**

The Office Action at pages 3 and 4 rejects claim 1 under 35 U.S.C. § 102(a) as being anticipated by Tabuchi et al. (JP 2000-273645-A). Applicants respectfully disagree.

Applicants' invention, as claimed in claim 1, pertains to a surface treatment apparatus for making raw material gas plasma by generating plasma, in a casing provided with plasma generation means, a raw material gas inlet and a substrate support table, by the plasma generation means and giving plasma treatment to the surface of a substrate placed on the substrate support table. A casing is defined into two chambers, a plasma generation chamber provided with the plasma generation means and a substrate treatment chamber provided with the substrate support table. The substrate treatment chamber and the plasma generation chamber are connected through one or more plasma nozzles. At least one of the plasma nozzles is made a hollow electrode discharge generation area.

Fig. 1 shows an example of Applicants' surface treatment apparatus 1 for making raw material gas plasma. The surface treatment apparatus 1 makes raw material gas plasma by generating plasma, in a casing 2 provided with plasma generation means, a raw material gas inlet 8 and a substrate support table 9, by the plasma generation means and giving plasma treatment to the surface of a substrate S placed on the substrate support table 9. The casing 2 is defined into two chambers, a plasma generation chamber 3 provided with the plasma generation means, and a substrate treatment chamber 4 provided with the substrate support table 9. The substrate treatment chamber 4 and the plasma generation chamber 3 are connected through one or more plasma nozzles 7. At least one of the plasma nozzles 7 is made a hollow electrode discharge generation area. See Applicants' Specification at page 33, line 5-page 34, line 12.

As claimed in claim 1, the at least one of the plasma nozzles 7 is made a hollow electrode discharge generation area. One example of the plasma nozzle 7 as a hollow electrode discharge generation area is described in Applicants' Specification at page 34, line 13-page 35, line 1. A plasma nozzle 7 being a hollow electrode discharge generation area provides advantages. For example, new plasma is generated at the plasma nozzle 7 and is introduced into the substrate treatment chamber 4 which increases the density of the plasma in the substrate treatment chamber 4 otherwise generated in the plasma generation chamber 3. Further, the hollow electrode discharge generation area of the plasma nozzle increases species contributing to the film formation on the substrate S. Even further, the speed of film formation on the substrate S is remarkably increased. See Applicants' Specification at page 40, line 10-page 41, line 5. Various other examples of Applicants' plasma nozzle as a hollow electrode discharge generation area are described in the Specification and shown in the drawings.

Turning to Tabuchi et al., Tabuchi et al. has the same Applicant as the assignee of the present application. Also, Tabuchi et al. and the present application have some common inventors. The present invention is an improvement over Tabuchi et al.

Tabuchi et al. uses inhomogeneous plasma electric discharge and does not describe plasma discharge with a hollow structure of electrodes at the nozzle. Therefore, Tabuchi et al. does not disclose the structure of Applicants' claimed invention. Further, Tabuchi et al. also does not disclose the effects obtained from hollow discharge. In contrast, according to the

present invention, hollow electrode discharge is generated actively by using the nozzle as a hollow electrode discharge generation area and, as a result, films with high crystallinity can be formed at a high speed without using other means for generating inhomogeneous electric discharge.

Thus, Applicants submit claim 1 as allowable over Tabuchi et al. and the § 102(a) rejection should be withdrawn.

The Office Action at pages 4 and 5 rejects claims 1 and 4 under 35 U.S.C. § 102(e) as being anticipated by Takahashi et al. (U.S. Patent No. 6,192,828 B1). Applicants respectfully disagree.

Takahashi et al. describes that a crystalline film can be obtained by using both a porous electrode and a pulse voltage impression. Takahashi et al. does not disclose a plasma nozzle as a hollow electrode discharge generation area or the effects obtained from the hollow electrode plasma discharge. In contrast, according to the present invention, hollow electrode discharge is generated actively by using the nozzle as a hollow electrode discharge generation area and, as a result, films with high crystallinity can be formed at a high speed without impressing a pulse voltage.

Thus, Applicants submit that claims 1 and 4 are allowable over Takahashi et al. and the § 102(e) rejection should be withdrawn.

The Office Action at pages 5 and 6 rejects claims 1 and 19 under 35 U.S.C. § 102(b) as being anticipated by Hartig et al. (U.S. Patent No. 5,683,548). Applicants respectfully disagree.

Hartig et al. uses inductively coupled discharge plasma by channels 38, 44. However, Hartig et al. does not disclose a plasma nozzle as a hollow electrode discharge generation area. The cylindrical structure 58 of Hartig et al. is not a metal electrode; rather, it is a dielectric housing in order to generate plasma. In Hartig et al., hollow discharge is not generated inside the dielectric cylinder. In addition, the inductively coupled plasma discharge of Hartig et al. is different from Applicants' hollow electrode discharge. Moreover, while it is possible to lead plasma generated by inductively coupled discharge to a hollow electrode structure and generate hollow discharge, its reverse is impossible. In contrast, according to the present invention,

hollow electrode discharge is generated actively by using the nozzle as a hollow electrode discharge generation area. As a result, the present invention provides the effect that films with high crystallinity can be formed at a high speed, which cannot be attained by inductively coupled discharge plasma and its nozzles.

As to claim 19, claim 19 has an additional effect that films with high crystallinity can be formed at a high speed by generating hollow electrode discharge, which is absolutely different from Hartig et al., and by applying substrate bias.

Thus, Applicants respectfully submit that claims 1 and 19 are allowable over Hartig et al. and the § 102(b) rejection should be withdrawn.

**Claim Rejections-35 U.S.C. § 103**

The Office Action at pages 6-9 enter various rejections under 35 U.S.C. § 103. Claims 4-12 were rejected under § 103(a) as being unpatentable over Tabuchi et al. Claim 19 stands rejected under § 103(a) as being unpatentable over Tabuchi et al. in view of Hartig et al. Claims 5-12 were rejected under § 103(a) as being unpatentable over Takahashi et al. Claim 19 stands rejected under § 103(a) as being unpatentable over Takahashi et al. in view of Hartig et al. Claims 5-9, 11 and 12 were rejected under § 103(a) as being unpatentable over Hartig et al. Applicants respectfully disagree.

First, the Office Action rejected claims 4-12 as being unpatentable over Tabuchi et al. However, as mentioned above, the present invention has new features and effects which Tabuchi et al. does not have. Moreover, generation of hollow discharge depends on process conditions such as gas pressure and impressed voltage. Prior art references may disclose the usage of plasma without hollow discharge with apparatuses of similar shapes, but the references can be distinguished even visually regarding generation of hollow discharge plasma. The speed of film formation and crystallinity of the film are far higher when hollow discharge is used, and the difference in plasma itself can be recognized by sight. Regarding change in shape of the hollow discharge electrode, generation of hollow discharge depends on process conditions as mentioned above, so even if an electrode is provided with pores arbitrarily, generation area of hollow

discharge cannot be controlled. Therefore, the apparatus of the present invention is not obvious to a person of ordinary skill in the art.

Second, the Office Action rejected claim 19 as being unpatentable over Tabuchi et al. in view of Hartig et al. However, as mentioned above, those references do not use hollow electrode discharge at all. Moreover, hollow electrode discharge effects cannot be used in the prior art disclosed in those references. In contrast, claim 19 has an advantageous effect that films with high crystallinity can be formed at a high speed, which the prior art cannot attain. Thus, claim 19 is not obvious.

Next, the Office Action rejected claims 5-12 as being unpatentable over Takahashi et al. However, the present invention is patentably different from Takahashi et al. in that, for example, films with high crystallinity can be formed at a high speed by actively using hollow electrode discharge. Hollow discharge depends on process conditions such as gas pressure and impressed voltage. As mentioned above, prior art references may disclose the usage of plasma without hollow discharge with apparatuses of similar shapes. However, they can be distinguished even visually regarding generation of hollow discharge plasma, and the functions of the prior art references and the present invention are also different.

Then, the Office Action rejected claim 19 as being unpatentable over Takahashi et al. in view of Hartig et al. However, those references do not use hollow electrode discharge at all. On the contrary, claim 19 of the present invention has an advantageous effect that films with high crystallinity can be formed at a high speed, which prior art cannot attain, and claim 19 is not obvious.

Finally, the Office Action rejected claims 5-9, 11, and 12 as being unpatentable over Hartig et al. However, as mentioned above, Hartig et al. does not use hollow electrode discharge at all. For the same reasons above, the apparatus of the present invention is not obvious to a person of ordinary skill in the art.

Thus, Applicants respectfully submit that all of the § 103 rejections have been overcome.

Furthermore, Applicants respectfully submit that the application is in condition for allowance.

Attached hereto is a marked-up version of the changes made to the specification and claims by the current amendment. The attached page is captioned "**Version with Markings to Show Changes Made**."

Respectfully submitted,

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## VERSION WITH MARKINGS TO SHOW CHANGES MADE

**In the Specification:**

When a number of the plasma nozzle are to be disposed, hollow discharge generated at all of these nozzles is preferable, as it allows to form ~~an~~ a uniform thin film at a high speed even for a large area substrate.

**In the Claims:**

1. (Amended) A surface treatment apparatus for making raw material gas plasma by generating plasma, in a casing provided with plasma generation means, a raw material gas inlet and a substrate support table, by the plasma generation means and giving plasma treatment to the surface of a substrate placed on said substrate support table, wherein:

said casing is defined into two chambers, a plasma generation chamber provided with said plasma generation means and a substrate treatment chamber provided with said substrate support table;

said substrate treatment chamber and said plasma generation chamber are connected through one or more plasma nozzles; and

at least one of said plasma nozzles is made a hollow electrode discharge generation area.

4. (Amended) A surface treatment apparatus according to ~~one of claims~~ claim 1 ~~to 3~~, wherein an opening width W(1) of the smallest portion on at least one of the plasma nozzles is set in a range satisfying either of $W(1) \leq 5L(e)$ or $W(1) \leq 20X$:

where L(e) is an electron mean free path in respect to atom or molecular species (active species) of the smallest diameter among raw material gas species and electrically neutral atom or molecular species (active species) produced there from by decomposition, under the desired plasma generation conditions; and

X is a thickness of a sheath layer generated under the desired plasma generation conditions.

5. (Amended) A surface treatment apparatus according to ~~one of claims~~ claim 1 ~~to 3~~, wherein said plasma nozzle forms a substantially continuous and elongated slit shape that can be drawn with a single stroke of the brush.

19. (Amended) A surface treatment apparatus of one of claims 1 ~~to 17~~ and 4-12, wherein said apparatus comprises potential applying means for applying a desired potential to the substrate.